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(54) METHOD AND APPARATUS FOR COATING PAPER OR THE LIKE

VERFAHREN UND VORRICHTUNG ZUR BESCHICHTUNG VON PAPIER UND DERGLEICHEN

PROCEDE ET APPAREIL POUR L'APPLICATION D'UN REVETEMENT SUR DU PAPIER OU SIMILAIRE

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Description

[0001] It is well known that onto paper, paper board, or other materials of this kind can be applied various substances to change the surface texture, colour or the like. These coatings often contain clay (kaolin) or other relatively heavy materials as talc or chalk and binders as latex or modified starch, for filling up the somewhat porous surface of the paper or paper board to produce a smooth surface.

[0002] The coatings improve the quality of the paper, e.g. the shine, the brightness, the transparency, the smoothness, the surface strength, the absorption characteristics. One or more coating layers are applied onto the surface of the uncoated paper to fill up roughness of the paper surface and thus to render the said surface even, to give a more smooth and microporous surface. Depending on the quality of the paper, onto the paper web are applied different amounts of coating in one or more steps. An appropriate surplus of wet coating is applied onto the paper web using a dosing device, through which the paper is conveyed. To give an even thickness to the coating on the surface of the paper web, a doctor or a so called doctor blade or knife, which extends over the whole width of the paper web, is installed spaced from the dosing device. Until 90 % of the coating is scraped off. This wears down the blade and the maintenance, e.g. the changing of the doctor, is considerably time consuming.

[0003] As a coating, e.g. only starch, can be employed, as is the case in manufacturing of copying or letter paper, then this is called surface sizing. In surface sizing after the surface coating, the paper web is led through a nip formed between two rolls. In among others the publications Tappi J. August 1992 pp 79-84 (Jarkko Tehomaa et al.: A comparison of different high speed surface sizing techniques for fine paper) and Tappi J. Dec. 1990 pp 69-75 (Charles P. Klass: Trends and developments in size press technology), examples on surface sizing are given.

[0004] It is well known in the field, that paper is usually manufactured in continuous process, where the web first has a very high water content, whereafter the water content is gradually decreased, until essentially all water has been removed from the web. Because of the nature of the process and apparatus for applying the coatings, the choice of the process step, where the coatings are to be added is very limited. Especially clay or the like is applied on the surface and scraped to the desired thickness using a doctor blade or a corresponding mechanical device, e.g. an air knife. Very many different types of doctors are known and even if in the present text for simplicity reference is always made to doctors, it is emphasized that the invention is not limited to the use of only doctors but that it can be applied to all such devices that are extending over essentially the whole width of the paper web and which are used after the paper coating has been applied.

[0005] A conventional doctor blade is illustrated in Patent application EP-A-0060114, which discloses a method of coating a substrate with microcapsules, comprising the step of dispensing the microcapsules in a liquid, applying the liquid to the surface of the substrate and removing all but the desired thickness of liquid using a doctor blade. A conventional use of rollers is illustrated in patent GB 1601282, wherein layers of starch are applied to the surface of a substrate in liquid form, following which the substrate is passed between couching rollers and counter rollers to remove the excess liquid.

[0006] Some efforts have been made to spray the coatings on paper like substrates, but these spray techniques have never led to successful application. In Finnish application 911390, corresponding to publication WO 90/03225, there is disclosed a process and apparatus for coating a web which avoids mechanical contact, in which process the web is conveyed continuously along a path, the coating material is formed on the web in a slurry containing a solid particulate coating, the slurry is broken up into small particles for producing a fog of coating material to be applied onto the web, said fog having solid particulate material as a gas suspension, a sufficient gas stream is produced to maintain the solid material in particle form in suspension, and the fog containing the solid particulate material is directed towards the web for adherence of the solid particulate material onto the web. The reason for using a fog to coat the paper was to prevent damage to the substrate from mechanical smoothening means.

[0007] For many years higher paper web speeds have been desired for to increase production rates. Presently paper web speeds between 1000-1500 m/min are common and in the future even greater speeds will be possible.

[0008] For resolving the problems mentioned above, according to the invention a process as disclosed in claim 1 and an apparatus as disclosed in claim 4 are provided.

[0009] The objective of this invention is generally coating or sizing paper webs or like and concerns especially a process and an apparatus for coating a web. Another objective of the invention is to obtain a smooth paper surface. Yet another objective is to obtain a better paper quality, so that the paper can be coated with a greater amount of coating and/or the formerly attained coating amounts can be obtained using fewer coating steps. The pressure of the mechanical doctor can be decreased. The doctor blade pressure needed is considerably smaller than in existing devices in industry. The wetting of the paper web can be decreased. The productional efficiency of the surface sizing is increased.

[0010] This invention comprises making a slurry to be used as the coating material mixtur or sizing mixture and producing a fog. The coating material mixture or sizing mixture, before adher nce onto the paper, is bro-

ken up into a fog using a gas under pressure. After spraying, the coated or surface sized web is treated by a doctor or it is pressed between two rotating rolls or like, to smooth the coating or sizing layer and to making possible the chemicals, the coating and/or the sizing to penetrate into the paper.

[0011] In different embodiments the fog can be mixed with such fogs that contain other coatings if desired; then the final coatings are directed towards the web. In one embodiment the fog and the web can contain static charges, which help the fog to adhere and to stay on the web, even if, the process is successful even without using static charges. Furthermore, the fog can be generated in many different ways e.g. by using normal spray nozzles. In the invention ultra sonic energy and ultra sonic nozzles well known in the field can be employed.

[0012] These and other features and advantages of the invention are disclosed in the following description, when read together with the therewith attached drawings, where:

Figure 1 presents a cross sectional view of a schematic drawing of a coating nozzle.

Figure 2 presents a schematic flow diagram showing the do-sing device of the invention for coating paper.

Figure 3 presents different alternatives for smoothing the paper web, which has been coated using a paper machine or a separate coating machine.

Figures 4 and 5 present structures of nozzles.

[0013] Referring now to the drawings and to the embodiments of this invention disclosed here, it should be mentioned, that many of the features disclosed in FI application 911390 can be incorporated to the apparatus.

[0014] In Figure 1 an example of an application nozzle 24 is given, where air channels 25 are disposed around the capillary tube 26 of the slurry channel. The coating slurry is brought in the form of a slurry to the slurry channel 26. The slurry channel and the air channels narrow off towards the outlet. The air from the air channels is directed to break up the slurry into a fog and to further break it up, if the slurry already has been reduced into a fog in an earlier stage. The coating mixture hits the paper web and adheres to it. The distance of the application nozzle from the paper can be adjusted according to the need. The slurry is conducted to the slurry channel in form of a slurry if it is dilute wherein it is broken up just a moment before it hits the paper. The outlet end of the nozzle has e.g. a diameter of 1-5 mm or 3-5 mm. The nozzles can be aligned in a row, over the width of the web to be coated, either in the same or a different plane, and the air and slurry channels are arranged concentrically so that the fog broken up through them is applied evenly on the surface of the paper. The nozzle according to Figure 1 can be formed into one uniform nozzle where the outlet of the slurry channel is formed into a slot extending over the whole width of the web and its dimensions e.g. 2-5 mm x 6 m. The air channels are then arranged on the both sides of the slot and spaced apart from each others. In the more advantageous situation a dosing device of the usual type can be replaced only by the nozzle 24 with the air and slurry channels. Figures 4 and 5 show further different embodiments of the nozzles.

[0015] Furthermore, the amount of the coating applied can be easily adjusted. The penetration of and the adhered coating can be optimized by defining for each spray a suitable hit angle of the spray. The optimal value of the angle is not critical in all circumstances as the excess coating can always be collected or scraped off, but then the paper strain is added. A suitable pressure for the breaking up/accelerating gas (air) is 0,5-25 bar. A great pressure usually leads to a greater coating mixture velocity after the nozzle and this results that the coating penetrates deeper in the paper pores. The deepest penetration in the paper is obtained when the nozzles are slightly inclined against the direction of the incoming paper web. The optimal angle of the nozzles against the paper web line depends, as was stated, on:

- the velocity of the paper web
- the average droplet velocity of the broken up coating fog produced by the nozzle (the velocity of the breaking up air, that breaks up drops and gives them velocity, which at the point of discharge can approach the sonic speed depending on the structure of the opening or/and the slot/slots),
- the distance of the nozzle from the web (0,02-2 m)
- the diameter (0,02-10 mm) of the application opening or the width of the coating slot of the nozzle and the starting velocity given to the coating/sizing by a pump or an inner ejector.

[0016] In displacing the fog the pressure can be adjusted as needed to obtain an acceptable coating. The apparatus is naturally provided with an appropriate air-conditioning system, which is not disclosed here.

[0017] After application the web is conveyed through the doctor 32. The doctor blade is pressed against the roll 33. It should be mentioned, that the knife pressure can be considerably lower than in coventional application techniques, as the amounts of the fed coating can be easily dosed, wherein an excess amount of coating can be avoided. The main function of the doctor can be to meter or level. In a pilot-plant test a coating amount of 25 g/m^2 was obtained in one coating step, whereas in conventional processes a coating amount of 15-16 g/m^2 in ne step was obtained on one side. A mechanical (or air) knife can function as brushing or removing slurry paste. The choice of the main function, between brush-

ing or removing the paste, depends on the speed of the web to be coated, the type of paste and on the desired amounts of coating. A high blade pressure leads to a scraping phenomena and to an unwanted straining of the paper in removing the paste from the paper web. It is to be noted, that wh n paper is sized with a starch solution, the characteristics of this solution are totally different from the usual mineral coating or slurry.

[0018] In the process according to the invention the surface sizing and application speeds can be increased and it is estimated that the velocity of 2000 m/min can be reached, which was the maximum speed of the test machine in one of the pilot-plant tests. Thus, it can be said, that the limit speed of the application can be said to be dependant on the mechanically reachable speed of the machine as on the application process itself. The application can be performed in one or more steps. The coated paper can be smoothened, doctored, instead of using a doctor or in combination with a doctor e.g. by passing it between two rolls. An air knife or air brush or any combination of these can also be employed.

[0019] Upon visual inspection using ultra violet light it was noticed, that, for both gravure paper and off set paper in experimental application tests using paper speeds from 1000 to 1800 m/min, the process according to the invention gave a smoother surface to the paper than non-using doctoring and spraying.

[0020] In the embodiment according to Figure 2 the slurry is removed from the tank 10 by a pump 14, the outlet of which is connected to a line 15 for feeding a nozzle 16. The nozzle 16 breaks up the slurry from the tank 10 so that the slurry becomes a spray having a very small particle size or a fog size. In this application the material will be referred to as a fog and it should be understood that this term includes range of forms from a very small particle aerosol to a relatively small particle spray.

[0021] The nozzle 16 may comprise many specific pi ces of hardware. It is possible, that by using the pump 14 having sufficient pressure, the nozzle 16 may actually be a fluid type nozzle, wherein the nozzle will break up the fluid that flows therethrough to produce a fine particle spray, or a nozzle, where a gas under pressure breaks up the liquid and mixes therewith to form a fog. It is also possible to use an ultrasonic nozzle, usually of the type disclosed in the US patent 4352459 of Berger et al. The ultrasonic nozzles are well known in the art, and those skilled in the art will understand without further explanation.

[0022] One further embodiment that the nozzle 16 may take, is a transducer located at the bottom of the tank 18. It will be noted, that the tank 18 is described as having some slurry in the bottom of it, and the fog in the upper part of the tank 18. By placing the transducer at the bottom of the tank 18, ultra sonic energy can break up the slurry into fine particles to produce the desired fog above the liquid, and the additional fog being generated is removed for use.

[0023] It will be noted that the fog from the tank 18 is directed to a mixing chamber 19, and further that there is a second tank 18A, which also has its output directed to the mixing chamber 19. If desired, one might have two or more tanks such as the tanks 18 and 18A, each of the tanks 18 and 18A containing a different slurry and different fog so that two or more materials can be coated on a web 11 simultaneously.

[0024] Another means for providing two different materials for coating the web 11 is to provide two or more of the tanks as the tank 10. In the Fig. 2 a second tank 10A is disclosed, and a pump 14A moves material from the tank 10A and feeds it through the line 15A to a nozzle 16A in the tank 18. Thus, two different types of fogs are generated within the tank 18 by the nozzles 16 and 16A. The mixed fogs will then be either directed to a mixing tank 19 or directly to the application nozzle 24.

[0025] This invention provides also an injection device 23, which injects air or other gas to the stream of fog. The injection means 23 are placed adjacent to the walls of the application nozzle 24 and in this position a curtain of gas is placed along the walls, to prevent the attachment of the droplets on the walls.

[0026] To assist in causing the fog to attach to the substrate 11, it is contemplated that a static electric charge will be utilized on the fog and on the web 11. Those skilled in the art will readily understand that the web 11 can be charged, and that the fog can be charged by means of grating or the like. For purposes of illustration a charge generator is indicated at 30, there being only one charge generator shown. Nevertheless, it will be understood, that one charge (e.g. a negative) can be generated on the substrate 11, while the opposite charge (e.g. a positive) can be placed on the fog. These opposite charges will cause the fog to be attracted to the substrate 11 and stick thereto.

[0027] Different alternatives for smoothing (doctoring) of the paper using a paper machine or separate application machines are disclosed in Figure 3. Figure 3a discloses an embodiment of a doctor 32, an air brush or their combination. Figure 3b discloses a pair of rollers 34, used for a surface sized paper web, through which rollers the paper web is conducted. An air knife presented by a broken line can be added after the roller pair, if desired. The paper web can move upwards or in a horizontal direction. A small amount of pigment can be added to the starch, and this is called pigmentation.

[0028] An important feature of this invention is the application of the fog containing coating material to a web 11 at low pressure and without mechanical manipulation or the like. This allows the system of the invention to be utilized for coating paper anywhere along the paper production line, from the first de-watering stage until the paper has been completely dried. If desired, the paper can be manufactured and rolled up, and the rolls can be transported to another location, unrolled and then coated using the system according to the inventi n.

[0029] It will therefore be seen that this invention provides an extremely simple method and apparatus for coating a paper web or like. Since the slurry to be coated on the web is transformed into a fog and the fog is applied at very low pressure, it will be understood, that the web will never be harmed, even when the web contains much water. Furthermore, it will be understood that any conventional drying technique is appropriate so that infrared lamps or the like can be utilized to dry the coating on paper or board.

[0030] The extra coating material that is accumulated to the doctor blade, can be collected by usual means for later exploitation.

[0031] The invention has been described above referring to only one of its preferable embodiments, but it is clear, that the invention can be realized in other possible ways within the scope of the claims without changing the scope of the present invention. It is possible to use different coating techniques or machines. A remarkable improvement has been done in view of known art.

Claims

1. A process for coating a paper web, a paper board web or the like (11), said process comprising the steps of breaking up a coating mixture into a fog, applying said fog under pressure through a nozzle (24) onto the web (11) and smoothening the web (11) coated by the fog by pressing between two rollers (34) located on opposite sides of the web; or by using a doctor blade (32), an air knife or an air brush.

2. A process according to claim 2, wherein the web (11) is smoothened using in combination at least two of an air knife, an air brush, a doctor and rollers.

3. A process according to any preceding claim, wherein the coating mixture comprises several slurries, the process including the steps of producing a fog from each slurry, mixing all the fogs created and directing the resulting mixture of fogs to the application nozzle (24).

4. An apparatus for coating a continuously moving paper web, board web or the like (11) with a slurry, the apparatus comprising a dosing device for the coating and an application nozzle (24) at a distance from the web (11) for breaking up the slurry into a fog by gas under pressure and applying said fog to the web; characterized by further comprising means for smoothening the web (11) coated by the fog by pressing between two rollers (34) located on opposite sides of the web; or by using a doctor blade (32), an air knife or an air brush.

5. An apparatus according to claim 4, including means (23) for producing a current of gas for entraining and carrying the fog through the application nozzle (24).

6. An apparatus according to claim 4 or claim 5, wherein the slurry is a starch slurry and two rollers (34) are provided on opposite sides of the web for smoothening the coated web (11).

7. An apparatus according to any of claims 4 to 6, wherein the application nozzle (24) for feeding the slurry is provided with a slurry channel (26) for directing the slurry and an air channel or channels (25) located adjacent to the slurry channel (26), the slurry channel (26) or a plurality of such slurry channels extending over the whole width of the web (11).

Patentansprüche

1. Verfahren zum Beschichten eines Papiergewebes, eines Kartongewebes oder dergleichen (11), mit folgenden Verfahrensschritten: Aufbrechen einer Beschichtungsmischung in einen Nebel, Aufbringen des Nebels unter Druck durch eine Düse (24) auf das Gewebe (11) und Glätten des durch den Nebel beschichteten Gewebes (11) durch Drücken zwischen zwei Rollen (34), die auf gegenüberliegenden Seiten des Gewebes angeordnet sind, oder durch Verwendung einer Abstreichklinge (32), eines Luftmessers oder einer Luftbürste.

2. Verfahren nach Anspruch 1, bei dem das Gewebe (11) durch Kombination von wenigstens zweien von folgenden Vorrichtungen geglättet wird: Luftmesser, Luftbürste, Abstreichmesser und Rollen.

3. Verfahren nach einem der vorhergehenden Ansprüche, bei dem die Beschichtungsmischung verschiedene Aufschlämmungen aufweist, wobei das Verfahren den Verfahrensschritt Herstellen eines Nebels aus jeder Aufschlämmung, Mischen aller hergestellten Nebel und Führen der sich ergebenden Nebelmischung zur Aufbringdüse (24).

4. Vorrichtung zum Beschichten eines sich kontinuierlich bewegenden Papiergewebes, Kartongewebes oder dergleichen (11) mit einer Aufschlämmung, wobei die Vorrichtung eine Dosiervorrichtung für die Beschichtung und eine Aufbringdüse (24) in einem Abstand vom Gewebe (11) aufweist zum Zuführen eines Nebels zum Gewebe. wobei die Aufschlämmung mit einem unter Druck stehenden Gas aufgebrochen wird; bevor sie am Gewebe anhaftet, gekennzeichnet durch weitere Einrichtungen zum Glätten des von dem Nebel beschichteten Gewebes (11) durch Drücken zwischen zwei Rollen (34), die auf gegenüberliegenden Seiten des Gewebes angeordnet sind, oder durch Verwendung

einer Abstreichklinge (32), eines Luftmessers oder einer Luftbürste.

5. Vorrichtung nach Anspruch 4, mit einer Einrichtung (23) zum Erzeugen eines Gasstroms zum Mitreißen und Transportieren des Nebels durch die Aufbringdüse (24).

6. Vorrichtung nach Anspruch 4 oder Anspruch 5, bei der die Aufschlämmung eine Stärkeaufschlämmung ist und bei der zwei Rollen (34) auf gegenüberliegenden Seiten des Gewebes zum Glätten des beschichteten Gewebes (11) vorgesehen sind.

7. Vorrichtung nach einem der Ansprüche 4 bis 6, bei der die Aufbringdüse (24) zum Aufbringen der Aufschlämmung mit einem Aufschlämmungskanal (26) zur Orientierung der Aufschlämmung und mit einem Luftkanal oder Luftkanälen (25) versehen ist, die neben dem Aufschlämmungskanal (26) angeordnet sind, wobei sich der Aufschlämmungskanal (26) oder eine Vielzahl derartiger Aufschlämmungskanäle über die gesamte Breite des Gewebes (11) erstrecken.

Revendications

1. Procédé pour coucher une bande de papier, une bande de carton ou l 'analogue (11), ledit procédé comprenant les étapes suivantes : désagréger un mélange de couchage en un brouillard, appliquer ledit brouillard sous pression à travers une buse (24) sur la bande (11) et lisser la bande (11) revêtue par le brouillard en la pressant entre deux rouleaux (34) disposés sur des côtés opposés de la bande, ou en utilisant une lame traînante (32), une lame d'air ou une brosse d'air.

2. Procédé selon la revendication 1, dans lequel la bande (11) est lissée en utilisant en combinaison au moins deux d'une lame d'air, d'une brosse d'air, d'une lame traînante et de rouleaux.

3. Procédé selon l'une des revendications précédentes, dans lequel le mélange de couchage comprend plusieurs suspensions épaisses, le procédé comprenant les étapes suivantes : produire un brouillard à partir de chaque suspension, mélanger tous les brouillards créés et diriger le mélange résultant de brouillards vers la buse d'application (24).

4. Appareil pour coucher une bande de papier, une bande de carton ou l'analogue (11) se déplaçant de façon continue avec une suspension épaisse, l'appareil comprenant un dispositif de dosage pour le couchage et une buse d'application (24) située à une certaine distance de la bande (11) pour amener un brouillard à la bande, la suspension étant désagrégée en un brouillard par un gaz sous pression avant d'adhérer sur la bande, caractérisé en outre en ce qu'il comprend des moyens pour lisser la bande (11) enduite par le brouillard en la pressant entre deux rouleaux (34) disposés sur des côtés opposés de la bande, ou en utilisant une lame traînante (32), une lame d'air ou une brosse d'air.

5. Appareil selon la revendication 4, comportant des moyens (23) pour produire un courant de gaz pour entraîner et transporter le brouillard à travers la buse d'application (24).

6. Appareil selon la revendication 4 ou la revendication 5, dans lequel la suspension est une suspension d'amidon et dans lequel deux rouleaux (34) sont prévus sur des côtés opposés de la bande pour lisser la bande enduite (11).

7. Appareil selon l'une des revendications 4 à 6, dans lequel la buse d'application (24) pour amener la suspension est équipée d'un canal de suspension (26) pour diriger la suspension et d'un ou plusieurs canaux d'air (25) disposés adjacents au canal de suspension (26), le canal de suspension (26) ou une multiplicité de tels canaux de suspension s'étendant sur toute la largeur de la bande (11).

FIG. 3a

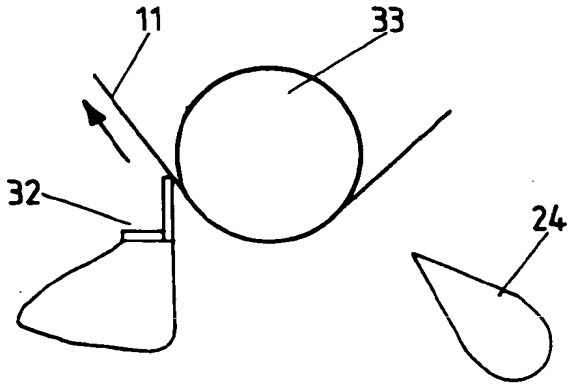
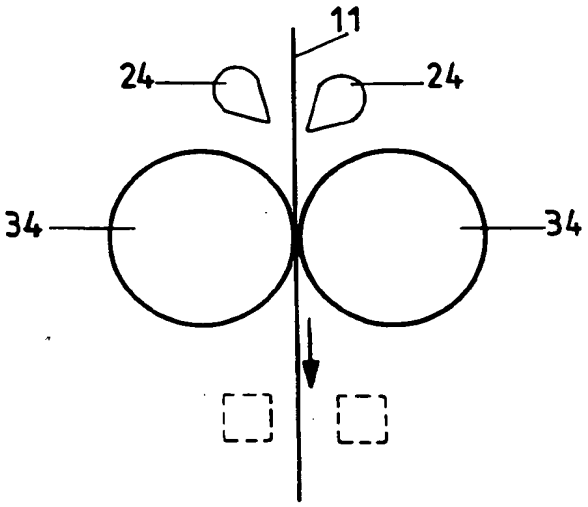


FIG. 3b



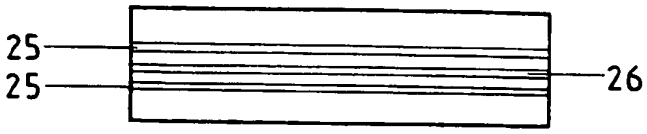


FIG. 5

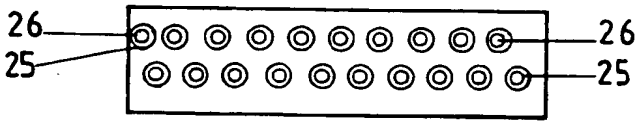


FIG. 4

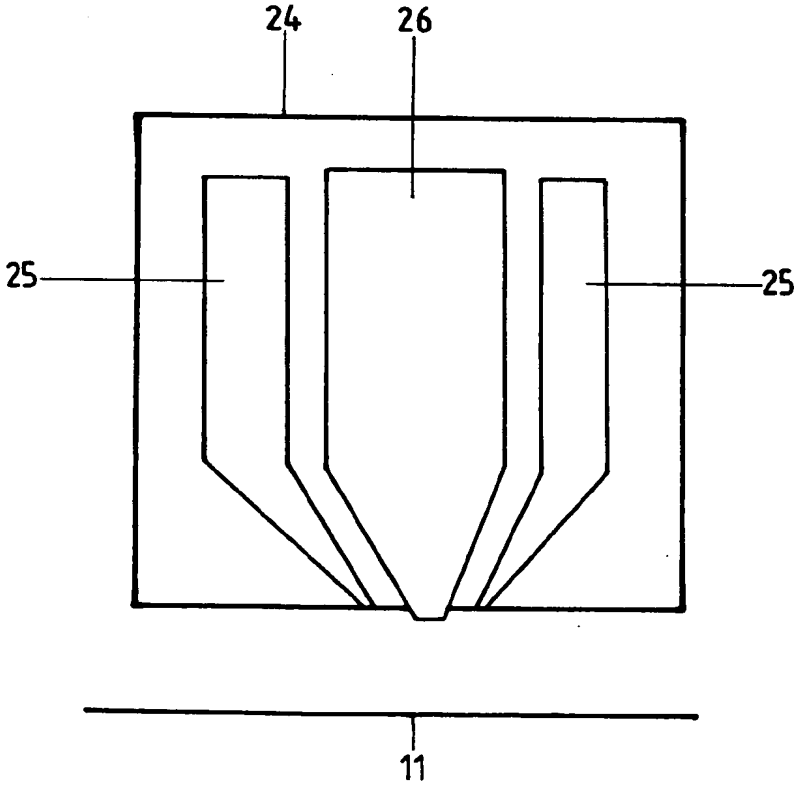


FIG. 1

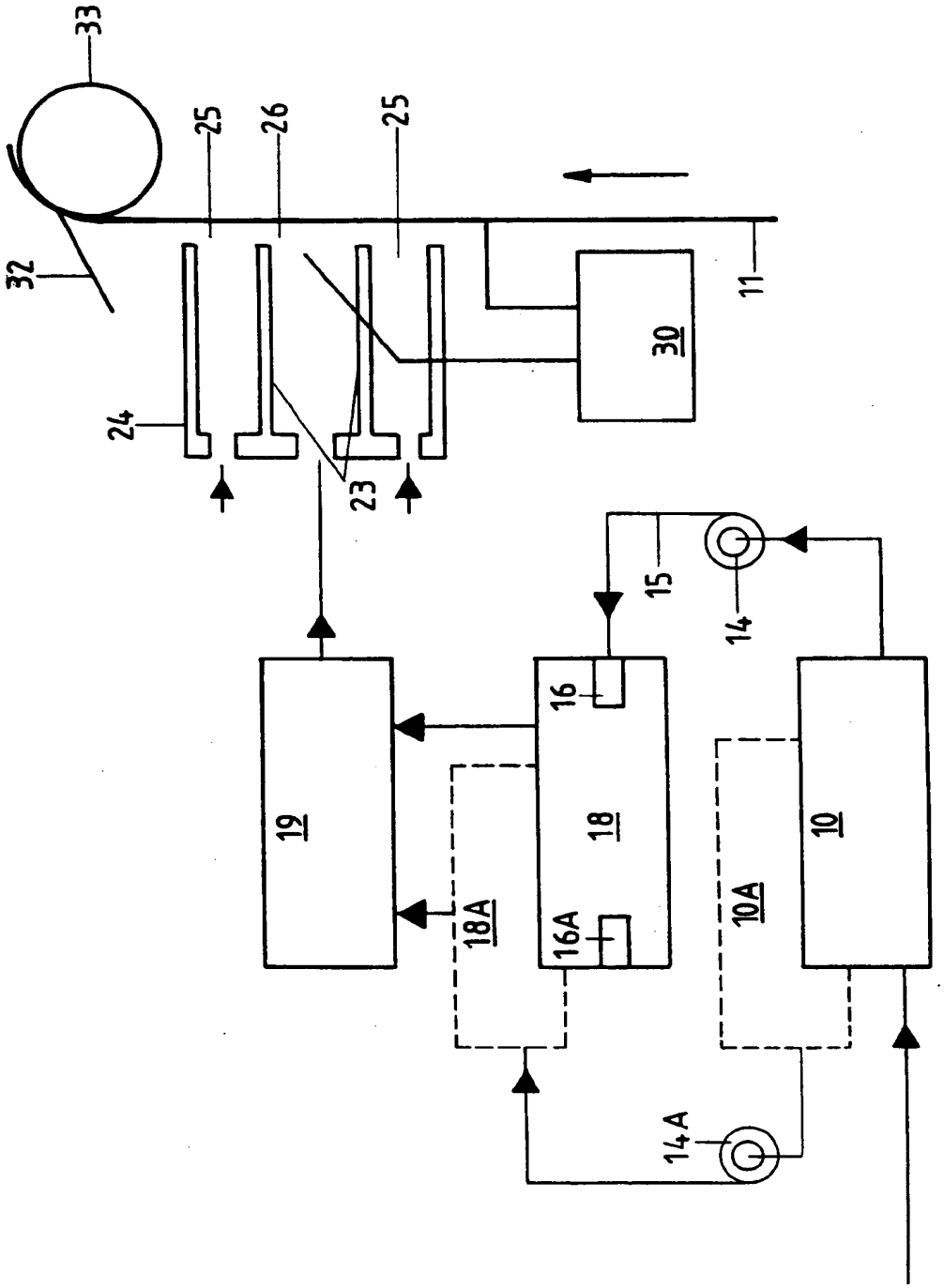


FIG. 2